Home Performance Standards: The Building Blocks of Healthy, Safe, and Energy-Efficient Homes

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Abstract

There are approximately 143 million homes in the United States. In the last ten years, up to 7 million existing single-family homes have been sold or transferred ownership. The median age of a typical American home is 44 years old, which means many of these homes were constructed prior to the broad adoption of modern building and energy codes. Frequently, existing homes suffer from issues that affect occupant health and safety, from poor indoor air quality to other home performance problems ranging from high energy consumption to poor thermal comfort.

The first part of this paper highlights how, as both an American National Standards Institute (ANSI)-accredited standards development organization and an ANSI National Accreditation Board (ANAB)-accredited certifying body, the Building Performance Institute (BPI) has developed standards for home energy auditing and quality implementation of home energy retrofits, which serve as the foundation of credentials that define the knowledge, skills, and abilities for home performance professionals nationwide. These standards and certifications have helped create consistent policies and practices used by weatherization and home performance programs and have raised the bar for the home performance workforce, as these dedicated individuals ensure occupant health and safety, building durability, energy efficiency, and home comfort are at the forefront of their work.

The second part of this paper explores the occupant health and safety issues that ANSI/BPI-1100 and ANSI/BPI-1200 address in depth. ANSI/BPI-1100 Home Energy Auditing Standard is an American National Standard that establishes the minimum criteria for conducting a building science-based residential whole-building assessment. Energy audits, also called comprehensive home assessments or whole building assessments, are performed using building science principles and they identify opportunities for improving energy efficiency while minimizing or eliminating health and safety hazards. The audit provides a list of prioritized recommendations to improve the energy efficiency of the home, as well as address comfort, occupant health and safety, and building durability issues. ANSI/BPI-1200 Standard Practice for Basic Analysis of Buildings is an American National Standard that establishes protocols for the basic analysis of buildings, providing specific procedures for how to meet the requirements of ANSI/BPI-1100. In the home performance industry, it is referred to as the "how to do an energy audit” standard.

The paper concludes with a broader view on how ANSI/BPI-1100 and ANSI/BPI-1200 support the United Nations 17 Sustainable Development Goals (SDGs) by helping to lead to a healthier, safer, and more energy-efficient world.

Aging Homes: A Growing Problem

The phrase “home is where the heart is” is generally attributed to Pliny the Elder (Gaius Plinius Secundus), a Roman naval commander who lived during a.d. 23-79.[1] Over time, these words have etched themselves into people’s hearts and minds, finding their way into media, literature, and even inspiring an Elvis Presley song. For many, home is more than just a dwelling with four walls and a roof. Home is a symbol of peace, stability, and longevity. It is the place where people raise their families and memories are made.

The U.S. census from 2020-2024 states that are approximately 143 million homes in the United States.[2] In 2023, most home sales were single-family houses, around 85 million.[3] The median age of a typical American home is 44 years.[4]

In the last ten years, existing single-family homes made up an estimated 4.8 to 7 million sales annually, a markedly higher number than newly constructed homes, which ranged from 400,000 to 800,000 annually.[5] The trend toward new construction is moving toward multifamily dwellings, rather than single-family homes, with developers completing 608,000 multifamily units in 2024.[6]

Clearly, the trend of homebuyers purchasing single-family housing is moving toward existing homes. Many of these existing homes were constructed before energy and building codes were established, and they often suffer from performance problems. Homes built before 1980 are six times more likely to have water intrusion issues in the basement (4.6%, compared to 0.8% of homes built after 1980). Additionally, roof leakage reports in older homes are nearly twice as high as those in newer homes (5.5%, as compared to 3.5%).[4]

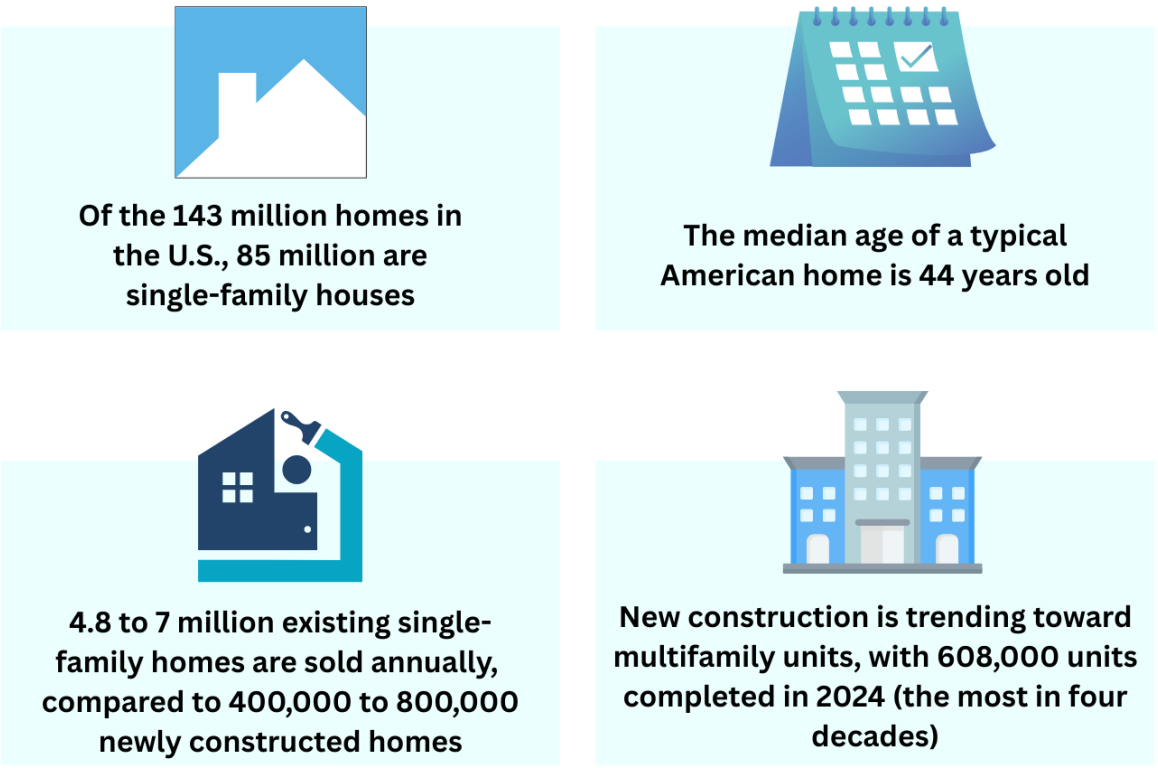

FIGURE 1: Facts and Trends in Housing[2-6]

There are millions of homes with outdated household and heating appliances, and millions with insulation that is either not present or in need of upgrade. This can lead to numerous indoor air quality (IAQ) issues including:

- Carbon monoxide (CO)
- Spilling/back-drafting of combustible appliances
- Volatile organic compounds (VOCs)
- Pollutants from the basement, crawlspaces, or exterior of the home
- Poor ventilation
- Mold/mildew

In addition to indoor air quality and occupant health and safety issues, many older homes suffer from performance problems ranging from high energy consumption to poor thermal comfort. Frequently, low-income households shoulder high energy burdens because the needed home energy retrofits and upgrades are out of their reach.

Solutions in Standardization

In response to these issues and the disproportionate energy burden borne by many low-income families, the Weatherization Assistance Program (WAP) began providing in-home energy education and basic energy conservation measures to income qualified families and individuals in 1976. When the WAP program expanded and a new industry focused on home performance began to take root and grow, the Building Performance Institute (BPI) was formed in 1993 to support the workforce. As the industry continued to expand and grow, BPI expanded their support for home performance workers with the development of certifications and standards focused on comprehensive home assessments and quality installation of energy conservation measures. For three decades, BPI has been developing standards and certifications to help define the knowledge, skills, and abilities for home performance professionals to have health, safety, durability, energy efficiency and comfort at the forefront of their work.

BPI is accredited by the American National Standards Institute (ANSI) as a developer of American National Standards and currently provides standards on home energy auditing, home performance related diagnostic testing, materials installation, quality control inspection and more.

FIGURE 2: Home Performance Topics that BPI Standards and Certifications Address

ANSI/BPI-1100[7] is the American National Standard for home energy auditing. This standard provides the requirements for energy auditing professions in the U.S. It establishes the minimum criteria for conducting a building science-based residential whole-building assessment. The goal of this standard

is to develop a comprehensive list of measures that lead to whole-house, building science-based home performance upgrades to single-family and 1-4 family homes.

ANSI/BPI-1100 is structured to be used in conjunction with ANSI/BPI-1200,[8] the American National Standard for the basic analysis of buildings. ANSI/BPI-1200 provides specific procedures for how to meet the requirements of ANSI/BPI-1100. In the home performance industry, it is referred to as the "how to do an energy audit" standard.

Energy audits are conducted based on building science principles and identify opportunities for improving energy efficiency while minimizing or eliminating health and safety hazards. The audit provides a list of prioritized recommendations to improve the energy efficiency of the home, as well as address comfort, safety and building durability issues. All audits include:

- An interview with the homeowner/occupants (if available) about any concerns they have related to home performance;
- Immediate disclosure to the homeowner/occupant when there is a suspected emergency or health and safety hazard or situation present in the home; and
- Homeowner/occupant education regarding efficient operation and use of appliances and equipment in the home.

Audit reports provide homeowners with:

- Results of diagnostic tests and visual/sensory inspections, including a summary of the diagnostic testing and inspections used and their purpose;
- A baseline energy-use analysis;
- Information on energy programs, incentives, regulations, and energy costs; and
- Information about the value of water efficiency.

ANSI/BPI-1100 provides auditors with guidance on prioritizing recommendations to homeowners to optimize home performance while maintaining or improving health and safety, occupant comfort, and building durability.

ANSI/BPI-1200 references numerous standards from many standards development organizations, including UL 913[9] (intrinsically safe apparatuses), ASHRAE 62.2[10] (ventilation in residential buildings), CSA/ANSI Z21.11.2[11] (gas-fired room heaters), NFPA 211[12] (chimneys, fireplaces, and vents), ANSI/RESNET/ICC 380[13] (testing of air tightness in buildings, heating and cooling air distribution systems, airflow of mechanical ventilation systems), and others.

ANSI accreditation of standards development procedures and approval process for American National Standards serve an important role in helping to facilitate cooperation and harmonization of standards development in the industry. Further, the ANSI process ensures that there is an opportunity for public input in standards, and ANSI-approved standards are developed with openness, consensus, and balance of interests at their core.

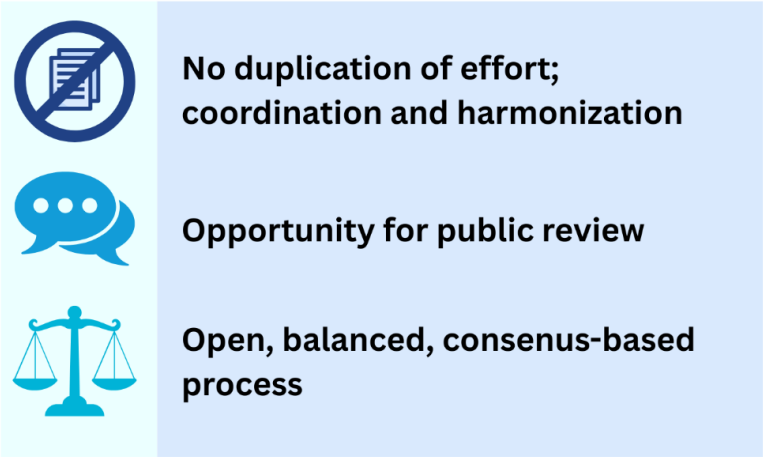

FIGURE 3: Benefits to the Public from ANSI Processes

Credentialing: Creating Consistent Practices in the Workforce

Creating consistency in practices throughout the workforce helps ensure quality in the work that is performed in homes. In addition to developing building science and energy efficiency standards, BPI develops credentials based on these standards. Along with being an ANSI-accredited standards development organization, BPI is also accredited by the ANSI National Accreditation Board (ANAB) as a certifying body for the Energy Auditor (EA) professional certification.

In 2024, BPI maintained a total of 18,144 active certifications across its credentialing programs, reflecting the need for qualified home performance professionals across the U.S. BPI certified professionals are active across the country, highlighting their importance in advancing building science, energy efficiency, and workforce development in every state.[14] BPI has a network of more than 100 test centers nationwide, which serve as local partners in making testing and credentials accessible.[14]

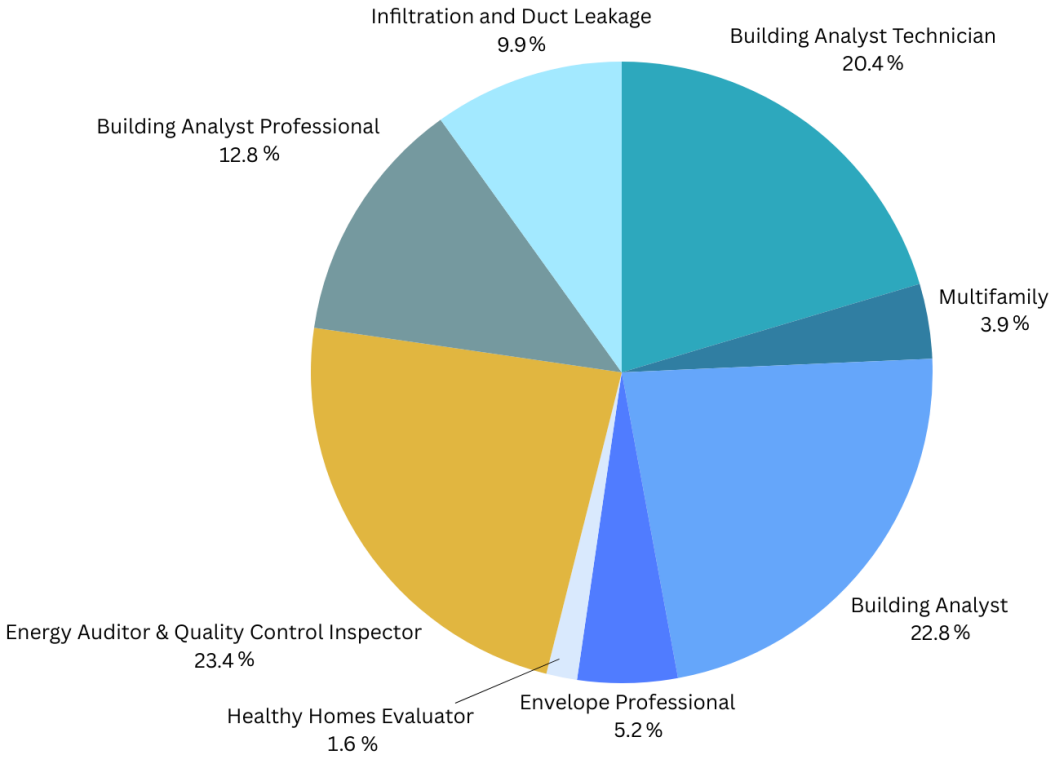

FIGURE 4: Percentages of Total Active BPI Certifications in the U.S. in 2024[14]

ANSI/BPI-1100 and ANSI/BPI-1200 are the referenced standards for BPI's Energy Auditor (EA) Certification. The certification consists of a written exam as well as a hands-on field exam, which tests areas covered in ANSI/BPI-1100 and ANSI/BPI-1200, including:

- Combustible gas and CO measurement;
- Testing indoor ambient CO levels and comparing results to current version of ANSI/BPI-1200;
- Testing indoor ambient air to confirm that combustible gases are below 10% of lower explosive limit (LEL) on each floor;
- Monitoring ambient CO levels measured in the combustion appliance zone (CAZ) during entire combustion safety testing; and
- Performing infiltration testing to determine where unintentional air leakage is present.

Energy Auditors evaluate the energy use, efficiency, and safety of a home, while utilizing their in-depth knowledge of diagnostic testing to evaluate the home for infiltration leakage and safe operation of

combustion appliances. The Energy Auditor uses the collected data and specialized modeling software to produce an audit report, develop a prioritized scope of work to address the homeowner's concerns, and identify areas of energy savings.

The U.S. Department of Energy (DOE) has recognized BPI's Energy Auditor certification as meeting Energy Skilled requirements in the Single Family Home Energy Audit category. One of the largest search engines shows a label on its business profiles when a company employs one or more employees with an Energy Skilled credential.

FIGURE 5: Department of Energy (DOE) Energy Skilled Recognition Badge[15]

ANSI/BPI-1100 and ANSI/BPI-1200 are the basis for BPI's Quality Control Inspector (QCI) certification. Individuals with this certification prove that they can verify the quality of retrofit work based on work plans and standards, conduct post-inspections using diagnostic equipment, and develop reports that specify corrective action.

BPI certified professionals distinguish themselves in the home performance industry with their advanced knowledge, commitment to continuing education and training. Contractors know BPI certified professionals are equipped to meet the challenges in the modern workforce, and homeowners know that these professionals will deliver quality services and workmanship while ensuring their needs and expectations are recognized and met.

The second part of this paper explores the health and safety issues that ANSI/BPI-1100 and ANSI/BPI-1200 address in depth.

Combustible Fuel Gases and Carbon Monoxide Poisoning

According to Underwriters Laboratory Standards and Engagement (ULSE)'s 2024 report, around 36% of adults in the U.S. (approximately 86 million) have no means of detecting carbon monoxide (CO) in their homes.[16] Additionally, USLE reported that approximately 69 million Americans (29%) believed they did not need, or were unsure whether they needed, a CO alarm in their home if they already had a smoke alarm.[16]

CO poisoning is often called a "silent threat," as it is a colorless, odorless gas that can cause serious illness and death if inhaled. Each year, more than 400 people in the U.S. die from unintentional CO poisoning not linked to fire, and more than 100,000 visit the emergency room.[17] People who are sleeping or intoxicated may die from CO poisoning before any physical symptoms manifest.

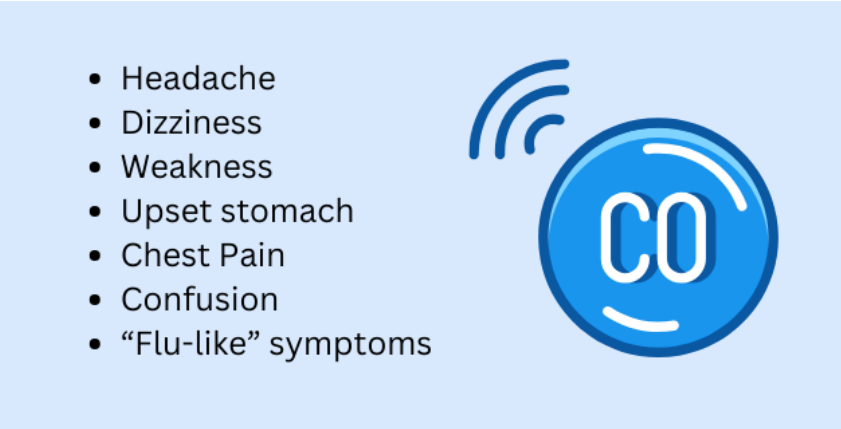

FIGURE 6: Most Common Symptoms of Carbon Monoxide Poisoning[17]

ANSI/BPI-1100 provides a list of items that are part of a combustible appliance and fuel distribution system inspection. This includes:

- Identification of building-related health and safety concerns that may require immediate remediation;
- Inspection of the ambient air for CO and combustible gas prior to undertaking inspections of fuel distribution systems and combustible appliances;
- Testing for gas leakage of accessible natural gas and propane piping systems;
- Inspection of oil-fired appliance fuel supply systems for leaks;

- Inspection of combustion venting systems for damage, leaks, disconnections, inadequate slope, and other safety hazards;
- Verification that sufficient combustion air is available;
- Spillage testing and CO measurement of all atmospherically vented combustion appliances;
- CO measurement of all direct vent and power-vented appliances;
- Testing of gas ovens and unvented appliances for CO; and
- Inspection of solid fuel burning appliances.

ANSI/BPI-1200 gives auditors guidance on how to conduct a visual inspection of the combustion appliance zone (CAZ) to determine whether there is sufficient clearance between combustion appliances (e.g., gasoline, oil-based products, solvents, varnishes, adhesives) to minimize the risk of fires and explosions. This standard also gives auditors the “how to” procedures and protocols for safe entry, CAZ depressurization testing, combustion appliance safety testing (CST) including testing appliances for spillage and excessive CO, and infiltration testing.

Mold, Moisture Control, and Homeowner Health

Mold can enter homes through open doorways, windows, vents, air conditioning, and heating events, and it can also attach itself to clothing or to a pet’s fur and be carried inside a house. When leakage occurs in roofs, walls, and other locations, mold spores will grow.[18] In May 2004, the Institute of Medicine of the National Academies found sufficient scientific evidence to link mold and damp conditions in buildings with asthma symptoms in individuals with this chronic condition, and coughing, wheezing, and upper respiratory tract symptoms found in otherwise healthy individuals were linked to mold in buildings.[19] Recent studies have suggested a possible link to early mold exposure to asthma in some children.[19, 20]

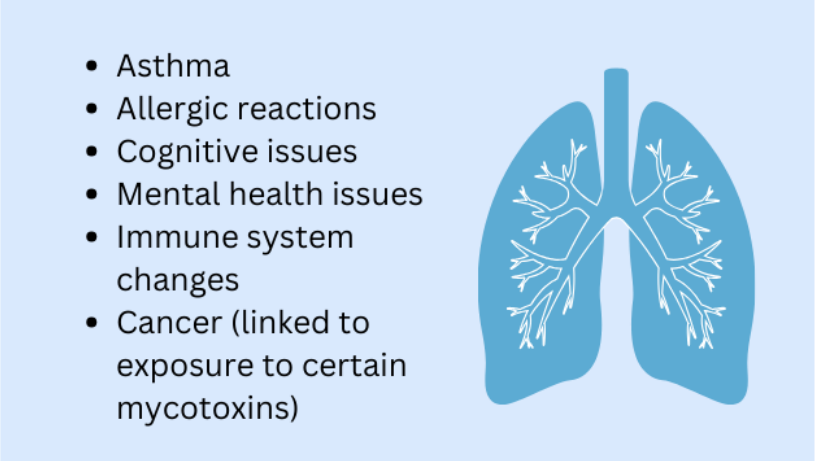

FIGURE 7: Common Health Effects in Moldy Environments[20]

In 2022, the National Institute for Occupational Safety and Health Centers for Disease Control and Prevention (NIOSH) published a dampness and mold assessment paper estimating that 47% of homes in the U.S. contain mold.[21] The report also cites a figure from the 2019 American Housing Survey, in which 9.4% of homes were reported to have exterior water leakage, and 7.6% homes interior water leakage.[21, 22]

Moisture control is considered the first line of defense in mold prevention. ANSI/BPI-1100 and ANSI/BPI-1200 give auditors guidance on inspecting for mold; auditors must inspect for:

- Evidence of roof leaks, foundation leaks, fenestration (design and placement of windows, doors, and other openings) assembly leaks, ground-water intrusion;
- Evidence of damage caused by interior water sources, such as plumbing leaks, condensation on piping, ductwork, or other surfaces;
- Effects of water damage on buildings, such as structural damage, mold, mildew, efflorescence, and stains; and
- Existing moisture-control strategies.

HVAC systems functioning properly contribute significantly to mitigation of mold. Inspection and evaluation of HVAC systems is included in both ANSI/BPI-1100 and ANSI/BPI-1200.

Building Enclosure Evaluation

Many of the existing homes in the U.S. were constructed before energy and building codes were established. Homes without adequate air sealing, insulation, and ventilation can be uncomfortable, expensive to heat and cool, and have lower resale value as compared to a home of the same age and style that has been upgraded.

Sometimes problems with bypasses between the attached garage and the living spaces causes health and safety concerns because pollutants from automobiles and volatile chemicals can be pulled into the home if there is not adequate sealing between the garage and living space.

ANSI/BPI-1100 and ANSI/BPI-1200 require auditors to evaluate the building enclosure for insulation levels and performance. Issues assessed, and their associated areas, include but are not limited to the following:

Area	Issues Addressed
Foundation	• Moisture control • Intentional or unintentional venting • Insulation degradation or other issues • Unintended air flow paths (e.g., bypasses between garage and living spaces)
Walls	• Moisture control • Insulation or lack thereof • Significant sources of air leakage • Deficiencies in exterior cladding or trim
Floors	• Moisture control • Insulation or lack thereof • Air leakage issues related to floor construction
Attics	• Insulation degradation or other issues • Transition areas for leakage remediation not easily visible • Adequate or inadequate attic ventilation according to local code
Fenestration	• Window deficiencies requiring repairs, retrofit, or replacement • Exterior door issues (e.g., missing or damaged caulking, missing or damaged trim or components)

FIGURE 8: Key Areas of Evaluation for Building Enclosures in ANSI/BPI-1100 and ANSI/BPI-1200

Other Health and Safety Concerns

During audits, BPI certified professionals often make note of other issues, bringing them to the attention of the occupant or helping to connect them to someone who can assist with repairs. Commonly found items include:

- Broken stairs
- Missing railings
- Carpets that are trip hazards
- Hazardous materials, such as lead based paint and asbestos
- Other issues that may be hazardous to homeowner and occupants

Energy Efficiency in Existing Homes

According to NEMA, baseload generation is the minimum level that a utility or power grid must produce constantly to meet the demands for electricity.[23] In the U.S., the electric grid is powered by multiple sources, including natural gas, nuclear, coal, and renewable sources (e.g., wind, solar). Coal and natural gas power plants account for the most power generation (about 60%).[23]

ANSI/BPI-1100 requires auditors to provide an estimate of homeowner baseload energy use and cost, including evaluation of:

- Refrigerator and freezer energy consumption
- Lighting efficiency and controls
- Pool and spa energy consumption and existing conservation strategies
- Other baseload energy-consuming devices

Energy auditors use the data collected during the audit, along with specialized energy modeling software to develop site specific recommendations to meet homeowner concerns and provide recommendations for energy efficiency improvements and upgrades. Energy modeling software can be used to analyze data, compare recommended energy upgrades, and develop cost-benefit analyses such as savings-to-investment ratios and simple payback, which provide meaningful information to aid homeowners in making informed decisions.

Conclusion: A Sustainable World Through Standards

In 2015, the United Nations Member States adopted the 2030 Agenda for Sustainable Development, a plan with 17 Sustainable Development Goals (SDGs) to achieve peace and prosperity.[24] ANSI/BPI-1100 and ANSI/BPI-1200 support UN Sustainable Development Goals 7, 9, and 11.

FIGURE 9: UN Sustainable Development Goals ANSI/BPI-1100 and ANSI/BPI-1200 Support[24]

With its focus on standards developed by ANSI-accredited procedures, and the use of American National Standards at the heart of its Energy Auditor and Quality Control Inspector certifications, BPI promotes quality and consistency in the home performance and energy efficiency workforce: helping to lead to a healthier, safer, and more energy-efficient world.

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